EnviroGroup Limited

The environmental solutions company

AS-0302

February 10, 2000

Louise Smart
Mary Margaret Golten
CDR Associates
100 Arapahoe Avenue
Boulder, CO 80302

Re: VB-I70

Dear Louise and Mary Margaret:

Please distribute the enclosed memorandum and attachments on leaded gasoline emissions to the VB-I70 working group.

Thanks very much.

Sincerely,
EnviroGroup Limited

David J. Folkes, P.E.
Principal

enc.

7208 South Tucson Way, Suite 125 • Englewood, Colorado 80112 • 303 790-1340 • Fax 303 790-1347

VASQUEZ BOULEVARD - I70 NPL SITE
MEMORANDUM

TO: Working Group
FROM: Dave Folkes, EnviroGroup
DATE: February 10, 2000

SUBJECT: Lead from Automobile Exhaust Emissions

At the January VB-I70 working group meeting, Loraine Granado of COPEEN indicated that they had collected data on traffic volume in the study area (e.g., vehicle-miles per year) and were interested in obtaining information that would allow them to estimate the amount of lead (Pb) emitted by these vehicles due to use of leaded gasoline.

The amount of lead emitted per vehicle mile is a function of the amount of lead in the gasoline (grams per gallon), the average amount of gasoline used per mile (gallons per mile), and the percent of the lead emitted, versus retained by oils in the engine. In other words,

Total Pb emitted/year = (total vehicle miles) x (gal/mile) x (grams/gal) x (%Pb emitted) [Eqn. 1]

As a short cut, some references (e.g., Attachment 1) estimate that the product of the last three terms in the above equation is about 0.1 to 0.3 grams Pb/mile, for gasoline containing about 2 grams of Pb per gallon. Therefore,

Total Pb emitted/year = (total vehicle miles) x 0.1 to 0.3 grams/mile [Eqn. 2]

However, the amount of lead in gasoline changed over the years. Based on Attachment 1, it appears that 2 grams of Pb per gallon of gasoline results in about 0.2 grams of Pb emitted per vehicle mile. Data we obtained from EPA (Attachment 2) indicates lead concentrations in gasoline ranged between 2 and 3 grams/gallon from the mid-fifties, when I-70 and I-25 were constructed through Denver, to 1973. After this time period, reductions in the use of leaded gasoline resulted in a decline in the average lead content of gasoline to about 1 gram by about 1979-80, and to about 0.1 gram by 1986. Therefore, the amount of lead emitted per vehicle mile likely averaged 0.25 grams/mile until 1973, steadily decreasing to about 0.1 grams/mile by 1980 and 0.01 grams/mile by 1986. Using these data, you can estimate the amount of lead emitted for each year, by using the number of vehicle miles travelled and estimated lead emissions per mile appropriate for that year, and totaling the emissions for all the years of interest to determine the total amount of lead emitted.

We also have data that allows calculation of lead emissions using Equation 1, but it is a more tedious approach and you end up with a number in the range quoted in Attachment 1. However, we can provide this additional information as well, if requested.

Please do not hesitate to call me at 303-790-1340 if you have any questions.

ATTACHMENT 1

Excerpt from "Environmental Contamination by Lead and Other Heavy Metals", by Solomon and Nantusch Institute for Environmental Studies, Univ. of Illinois at Urbana-Champaign, July 1977 (page 64)

ENVIRONMENTAL CONTAMINATION BY LEAD AND OTHER HEAVY METALS

VOLUME III: DISTRIBUTION AND CHARACTERIZATION OF URBAN DUSTS

by

R. L. Solomon and D. F. S. Natusch

Edited by G. L. Rolfe and K. A. Reinbold

Final Report

NATIONAL SCIENCE FOUNDATION RANN PROGRAM

Grants GI-31605 and ERT 74-24276

July 1977

Vol. I: Intro/Summary

II: Ecosystem analysis

IV: Soil, water, Plant, Air Study

V: Synthesis + Modeling

INSTITUTE FOR ENVIRONMENTAL STUDIES

University of Illinois at Urbana-Champaign

5 SOLUBILITY OF AUTOMOTIVE LEAD

R. L. Solomon

Because heavy metals in urban stormwater may eventually contaminate drinking water supplies, much interest has recently been expressed in the solubility of trace metals, particularly lead (Hem and Durum, 1973; Sartor and Boyd, 1972; Nightingale, 1975). The tetraethyl species of lead is present in gasoline in amounts of approximately 2 g/gal and is emitted in automobile exhaust at a rate of 0.1 to 0.3 g/mi. The emitted particulate lead settles and accumulates in road dust in very large quantities, as shown in the studies reported in Chapter 2 and by Solomon and Hartford (1976). In the small urban community studied (Champaign-Urbana, Illinois), gutter dust samples taken on heavily traveled streets (12,000 to 20,000 cars/day) had lead concentrations from 5,800 to 12,300 µg Pb/g dust, indicating total lead contents from 1 to 24 g per square meter of street surface. These data are for the sieved fraction of the gutter dust having particle sizes less than 600 µm.

Previous studies have generally considered the solubility of pure lead compounds. In this study representative samples of actual street dusts were used, and the water solubility of the lead in these dusts was measured.

Experimental Procedure

The vacuuming technique used to collect dust samples is described in Appendix A. Lead solubility was measured in polypropylene beakers. Maximum agitation rates were used to simulate the conditions of water runoff during a rainstorm. In general, 30 g of dust (<600 µm in size) and 100 g of water (tapwater and rainwater) were used. Liquid samples (10 ml) were removed at hourly intervals for the first four hours of an experiment. In some cases a fifth hourly sample was taken, while in others a 24-hour sample was withdrawn. A polycarbonate syringe fitted with an inline Millipore filter was used to withdraw the sample, which was then placed in a polyethylene vial and immediately acidified with 25 µl of 12 M HCl. Lead assays were made by atomic absorption spectroscopy using an Instrumentation Laboratory Model 251 with a detection limit of 0.05 ppm lead. The relative standard deviation at the detection limit

ATTACHMENT 2

Lead Concentrations in Gasoline, 1955 - 1991
Information provided by Fuels & Energy Division, US EPA

EnviroGroup Limited

INTERNAL MEMO

TO: Dave Folkes **DATE:** February 7, 2000

FROM: Sean Carroll SMC

SUBJECT: Phone conversation with James W. Caldwell of US EPA, regarding lead in gasoline.

On January 6, 1999, I spoke with James W. Caldwell of the US EPA Fuels and Energy Division, Office of Mobile Sources, regarding the amount of lead added to gasoline before 1967. He quoted information on grams of lead added to each gallon of gasoline, taken from a Chemical Economics Handbook, researched and provided to the EPA by SRI International of Menlo Park, CA. This book is not published; SRI is a research consulting company and provided this work to the EPA under contract. Following is a summary of the data he read to me:

Year	Grams Pb/gallon		Year	Grams Pb/gallon
1955	2.38		1960	2.04
1956	2.44		1961	2.94
1957	Did not record		1962	2.01
1958	2.38		1963	2.15
1959	2.12		1964	2.25

This information was used in conjunction with the US EPA Fuels and Energy Division data, also provided by James Caldwell, to estimate the mass of lead emitted by a motor vehicle as a function of the year, fuel economy and distance traveled.

caldwell.jim@epamail.epa.gov

James W. Caldwell, P.E.

Fuels and Energy Division
Office of Mobile Sources (6406J)
U.S. Environmental Protection Agency
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FUELS AND ENERGY DIVISION (6406J)
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

* LEAD AND GASOLINE USAGE SUMMARY 1967 - 1991
UNITED STATES

YEAR: 1967		Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					77.54
Lead	Bgm.					186.43
Lead	Ktons					205.32
Concentration	gptg ← grams per total gallons					2.40

* LEAD USED IN GASOLINE PRODUCTION

YEAR: 1968		Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					81.48
Lead	Bgm.					201.40
Lead	Ktons					221.81
Concentration	gptg					2.47

YEAR: 1969		Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					85.18
Lead	Bgm.					210.01
Lead	Ktons					231.29
Concentration	gptg					2.47

YEAR: 1970		Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					88.42
Lead	Bgm.					211.37
Lead	Ktons					232.79
Concentration	gptg					2.39

YEAR: 1971		Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					82.51
Lead	Bgm.					200.94
Lead	Ktons					221.30
Concentration	gptg					2.44

YEAR:	1972	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					97.44
Lead	Bgm.					205.52
Lead	Ktons					226.34
Concentration	gptg					2.11

YEAR:	1973	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					100.68
Lead	Bgm.					205.52
Lead	Ktons					226.34
Concentration	gptg					2.04

YEAR:	1974	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					98.17
Lead	Bgm.					176.03
Lead	Ktons					193.87
Concentration	gptg					1.79

Reflects introduction of Unleaded gasoline

YEAR:	1975	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Total Gasoline	Bgal.					100.53
Lead	Bgm.					158.52
Lead	Ktons					174.58
Concentration	gptg					1.58

YEAR:	1976	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	18.06	22.43	22.32	21.50	84.31
Unleaded Gasoline	Bgal.	3.75	5.37	6.08	6.20	21.40
Total Gasoline	Bgal.	21.81	27.80	28.40	27.70	105.71
Lead	Bgm.	48.00	48.60	49.10	40.70	186.40
Lead	Ktons	31.38	53.52	54.07	44.82	205.29
Concentration	gplg	2.66	2.17	2.20	1.89	2.21
Concentration	gptg	2.20	1.75	1.73	1.47	1.76
Percent Unleaded	%	17.2	19.3	21.4	22.4	20.2

YEAR:	1977	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	20.57	20.98	20.55	20.94	83.04
Unleaded Gasoline	Bgal.	6.53	7.22	7.95	8.43	30.13
Total Gasoline	Bgal.	27.10	28.20	28.50	29.37	113.17
Lead	Bgm.	39.30	45.00	45.20	39.19	168.69
Lead	Ktons	43.28	49.56	49.78	43.16	185.76
Concentration	gplg	1.91	2.14	2.20	1.87	2.03
Concentration	gptg	1.45	1.60	1.59	1.33	1.49
Percent Unleaded	%	24.1	25.6	27.9	28.7	26.6

YEAR:	1978	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	19.49	19.41	19.98	19.89	78.78
Unleaded Gasoline	Bgal.	8.28	8.68	9.89	10.16	37.00
Total Gasoline	Bgal.	27.77	28.09	29.87	30.05	115.78
Lead	Bgm.	32.60	37.03	43.47	40.15	153.25
Lead	Ktons	35.90	40.78	47.87	44.22	168.78
Concentration	gplg	1.67	1.91	2.18	2.02	1.95
Concentration	gptg	1.17	1.32	1.46	1.34	1.32
Percent Unleaded	%	29.8	30.9	33.1	33.8	32.0

YEAR:	1979	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	17.73	17.56	17.43	16.86	69.58
Unleaded Gasoline	Bgal.	9.67	10.22	10.78	10.96	41.63
Total Gasoline	Bgal.	27.40	27.78	28.21	27.82	111.21
Lead	Bgm.	34.38	35.18	37.33	22.60	129.49
Lead	Ktons	37.86	38.74	41.11	24.89	142.61
Concentration	gplg	1.94	2.00	2.14	1.34	1.86
Concentration	gptg	1.25	1.27	1.32	0.81	1.16
Percent Unleaded	%	35.3	36.8	38.2	39.4	37.4

YEAR:	1980	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	17.14	16.71	14.76	14.47	63.09
Unleaded Gasoline	Bgal.	12.16	11.96	11.64	11.99	47.74
Total Gasoline	Bgal.	29.30	28.67	26.40	26.46	110.83
Lead	Bgm.	21.24	20.89	21.30	15.04	78.47
Lead	Ktons	23.39	23.01	23.46	16.56	86.42
Concentration	gplg	1.24	1.25	1.44	1.04	1.24
Concentration	gptg	0.72	0.73	0.81	0.57	0.71
Percent Unleaded	%	41.5	41.7	44.1	45.3	43.1

YEAR:	1981	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	13.13	12.58	13.62	13.38	52.70
Unleaded Gasoline	Bgal.	12.03	12.08	12.92	12.90	49.94
Total Gasoline	Bgal.	25.16	24.66	26.54	26.28	102.64
Lead	Bgm.	14.57	14.10	16.00	16.29	60.96
Lead	Ktons	16.05	15.53	17.62	17.94	67.14
Concentration	gplg	1.11	1.12	1.18	1.22	1.16
Concentration	gptg	0.58	0.57	0.60	0.62	0.59
Percent Unleaded	%	47.8	49.0	48.7	49.1	48.7

YEAR:	1982	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	11.19	12.84	12.99	11.67	48.69
Unleaded Gasoline	Bgal.	11.64	12.59	13.80	12.79	50.82
Total Gasoline	Bgal.	22.83	25.43	26.79	24.46	99.51
Lead	Bgm.	13.42	16.89	17.79	12.99	61.09
Lead	Ktons	14.78	18.60	19.59	14.31	67.28
Concentration	gplg	1.20	1.32	1.37	1.11	1.25
Concentration	gptg	0.59	0.66	0.66	0.53	0.61
Percent Unleaded	%	51.0	49.5	51.5	52.3	51.1

YEAR:	1983	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	11.06	12.24	12.60	11.43	47.33
Unleaded Gasoline	Bgal.	12.66	13.56	14.63	13.85	54.70
Total Gasoline	Bgal.	23.72	25.80	27.23	25.28	102.03
Lead	Bgm.	12.02	13.86	13.64	12.07	51.59
Lead	Ktons	13.24	15.26	15.02	13.29	56.82
Concentration	gplg	1.09	1.13	1.08	1.06	1.09
Concentration	gptg	0.51	0.54	0.50	0.48	0.51
Percent Unleaded	%	53.4	52.6	53.7	54.8	53.6

YEAR:	1984	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	11.03	10.97	10.74	11.03	43.77
Unleaded Gasoline	Bgal.	14.42	14.97	16.17	16.34	61.90
Total Gasoline	Bgal.	25.45	25.94	26.91	27.37	105.67
Lead	Bgm.	11.82	11.90	11.52	10.93	46.17
Lead	Ktons	13.02	13.11	12.69	12.04	50.85
Concentration	gplg	1.07	1.08	1.07	0.99	1.05
Concentration	gptg	0.46	0.46	0.43	0.40	0.44
Percent Unleaded	%	56.7	57.7	60.1	59.7	58.6

YEAR:	1985	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	9.00	10.90	9.54	9.42	38.86
Unleaded Gasoline	Bgal.	15.30	16.40	17.73	16.19	65.62
Total Gasoline	Bgal.	24.30	27.30	27.27	25.61	104.48
Lead	Bgm.	5.90	6.50	4.11	3.55	20.06
Lead	Ktons	6.50	7.16	4.53	3.91	22.09
Concentration	gplg	0.66	0.60	0.43	0.38	0.52
Concentration	gptg	0.24	0.24	0.15	0.14	0.19
Percent Unleaded	%	63.0	60.1	65.0	63.2	62.8

YEAR:	1986	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	7.61	9.20	8.32	7.70	32.83
Unleaded Gasoline	Bgal.	17.12	18.50	19.58	20.16	75.36
Total Gasoline	Bgal.	24.73	27.70	27.90	27.86	108.19
Lead	Bgm.	2.37	3.70	2.49	1.71	10.27
Lead	Ktons	2.61	4.07	2.74	1.88	11.31
Concentration	gplg	0.31	0.40	0.30	0.22	0.31
Concentration	gptg	0.10	0.13	0.09	0.06	0.09
Percent Unleaded	%	69.2	66.8	70.2	72.4	69.7

YEAR:	1987	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	6.37	6.72	6.51	5.86	25.46
Unleaded Gasoline	Bgal.	20.33	21.91	21.31	22.05	85.60
Total Gasoline	Bgal.	26.70	28.63	27.82	27.91	111.06
Lead	Bgm.	1.43	1.52	1.42	1.29	5.66
Lead	Ktons	1.57	1.67	1.56	1.42	6.23
Concentration	gplg	0.22	0.23	0.22	0.22	0.22
Concentration	gptg	0.05	0.05	0.05	0.05	0.05
Percent Unleaded	%	76.1	76.5	76.6	79.0	77.1

YEAR:	1988	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	4.92	5.19	4.89	4.27	19.27
Unleaded Gasoline	Bgal.	21.79	22.22	23.70	23.75	91.46
Total Gasoline	Bgal.	26.71	27.41	28.59	28.02	110.73
Lead	Bgm.	0.44	0.47	0.43	0.38	1.72
Lead	Ktons	0.48	0.52	0.47	0.42	1.89
Concentration	gplg	0.089	0.091	0.088	0.089	0.089
Concentration	gptg	0.016	0.017	0.015	0.014	0.016
Percent Unleaded	%	81.6	81.1	82.9	84.8	82.6

YEAR:	1989	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	3.19	2.92	2.45	1.81	10.37
Unleaded Gasoline	Bgal.	22.57	22.75	24.85	24.78	94.95
Total Gasoline	Bgal.	25.76	25.67	27.30	26.59	105.32
Lead	Bgm.	0.28	0.26	0.22	0.16	0.92
Lead	Ktons	0.31	0.29	0.24	0.18	1.01
Concentration	gplg	0.088	0.089	0.090	0.088	0.089
Concentration	gptg	0.011	0.010	0.008	0.006	0.009
Percent Unleaded	%	87.6	88.6	91.0	93.2	90.2

YEAR:	1990	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	1.30	1.44	1.39	0.97	5.10
Unleaded Gasoline	Bgal.	24.05	24.95	26.18	24.15	99.33
Total Gasoline	Bgal.	25.35	26.39	27.57	25.12	104.43
Lead	Bgm.	0.11	0.12	0.12	0.08	0.43
Lead	Ktons	0.12	0.13	0.13	0.09	0.47
Concentration	gplg	0.085	0.083	0.086	0.082	0.084
Concentration	gptg	0.004	0.005	0.004	0.003	0.004
Percent Unleaded	%	94.9	94.5	95.0	96.1	95.1

YEAR:	1991	Qtr.1	Qtr. 2	Qtr. 3	Qtr. 4	Total
Leaded Gasoline	Bgal.	0.81	0.85	0.86	0.58	3.10
Unleaded Gasoline	Bgal.	22.99	24.68	22.64	24.68	94.99
Total Gasoline	Bgal.	23.80	25.53	23.50	25.26	98.09
Lead	Bgm.	0.07	0.07	0.07	0.04	0.25
Lead	Ktons	0.08	0.08	0.08	0.04	0.28
Concentration	gplg	0.086	0.082	0.081	0.069	0.081
Concentration	gptg	0.003	0.003	0.003	0.002	0.003
Percent Unleaded	%	96.6	96.7	96.3	97.7	96.8

***** Partial Year
Latest Revision: June 17, 1992
Totals Current as of Quarter 4 Year: 1991

1967-75 - BASED ON INDUSTRY DATA.

1976-91 - BASED ON REFINER REPORTS TO EPA PER 40 CFR 80.